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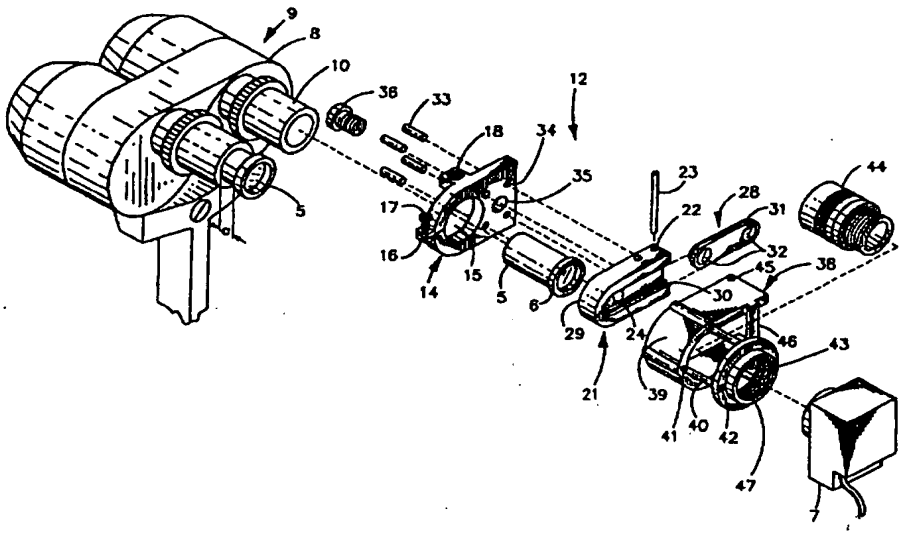

(57) Abstract

The present invention provides a device including an adapter that converts pre-existing eye examination units, such as converging optics slit lamps, into visual recording eye examination units. One embodiment of the adapter comprises a body with a front and rear aperture. The front aperture (68) is formed to matingly receive an eye piece (5) of an eye examination unit and the rear aperture (71) is formed to receive a camera lens (70). An alternate embodiment of the adapter comprises a clamp member (12) and a camera frame member (38) pivotally connected to said clamp member (12) with a spacer and filter element (21) positioned between the clamp member (12) and frame member (38). Another embodiment of the adapter comprises a viewing tube (50) connected to a head portion (51) and having a first line of sight. A prism (53) positioned in the head portion directs said first line of sight to a second line of sight.

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A CAMERA ADAPTER FOR AN EYE EXAMINATION DEVICE

TECHNICAL FIELD

The present invention relates to ophthalmological devices and in particular devices for photographing or video taping the eye as viewed through standard examining equipment, such as a conventional ophthalmic slit-lamp or bio-microscope. Furthermore, the present invention has unique application to the area of ocular angiography.

BACKGROUND ART

The prior art contains numerous devices designed specifically for photographing and/or video taping various parts of a human eye undergoing examination. These devices generally consist of a series of lenses producing the properly magnified and focused image of the eye and a camera device or video device to record this image. A platform mounted version of such a device can be seen in U.S. Patent 3,915,564 to Urban and a more modern, portable device can be seen in U.S. Patent 5,125,730 to Taylor, et al.

While not the only use for devices as described above, some of these devices may also be beneficial in the area of angiography. Angiography generally consists of introducing a light excitable dye into the blood supply circulating through the eye. As the dye carrying blood flows through blood vessels in the eye, the eye is illuminated with a wavelength of light which excites the dye and causes the dye to emit light itself. An "exciter filter" will be placed between the light source and the eye which will filter out all wavelengths of light except the wavelength which excites the dye. A second filter or "barrier filter" will be positioned between the eye and the observer. The barrier filter will filter out all wavelengths of light except those emitted by the dye. The angiography procedure will typically be fluorescein angiography, but may also be indocyanine green (or ICG) angiography. When employing fluorescein

angiography, the exciter filter will be blue-green and the barrier filter will be yellow. When employing ICG angiography, the exciter filter and the barrier filter will be infra-red.

The angiography process allows the eye examiner to obtain a detailed image of the blood circulatory conditions in the eye. The image produced through fluorescein or ICG angiography is generally recorded by photographic or videographic devices such as described in the above mentioned patents.

However, while some prior art devices can perform angiography and other procedures, they also have numerous disadvantages. These devices typically require specialized training of the medical personnel using the camera rather than allowing personnel to use skills already developed for existing devices such as slit-lamps. The prior art devices typically use film that must be developed. This requires the eye care practitioner to have his own dark room or experience considerable delays by sending film to an out-of-house developing lab. Even with a dark room, it may be several hours (long after the patient has departed) before the results of the exam can be reviewed. Nor are the prior art devices typically portable, but rather because of their size, are difficult to conveniently move to different locations. Although the above cited Taylor patent discloses a portable device, it is still comparatively large and expensive. Also, because these devices employ both high grade optics and complex photographic or videographic equipment, they are necessarily expensive to produce. In view of these disadvantages, many eye care practitioners are forced to refer a patient to a specialist in this field, entailing more delays and expense for the patient. Often, the ophthalmologist or optometrist has need of such a specialized device for performing videographic or angiographic procedures, but the considerable capital investment is prohibitive.

What is needed and what would be a great advance in the art is a device that would allow widely existing optical examining devices, such as converging optics slit lamps, to be

adapted for photographic, videographic or angiographic recording. Converging optics slit lamps are one of the most common examination devices used by eye care practitioners. None of the prior art devices allow conversion of the pre-existing optics on a converging optics slit lamp into a videographic device for angiographic or other applications.

The present invention is not only a device capable of adapting converging optics slit lamps to photographic, videographic or angiographic recording units, but also has numerous additional advantages. The present invention is easily portable and may be moved to different locations or just as easily to different slit-lamps located in the same office building. Additionally, the present invention can quickly be positioned on the slit-lamp when videographic or angiographic recording is required and then quickly removed when the procedure is finished. This ease of transformation means that a slit-lamp does not have to be dedicated to only videographic use, but may also be quickly converted back to its traditional operation. Furthermore, by providing a method of interfacing a video camera with an existing slit-lamp, the present invention provides instantaneous, real time images of the eye being examined. There are no delays or expenses associated with developing or dark rooms. Also, because the image of the eye is reproducible on a video screen in the examination room, the patient can immediately be shown the results of the eye examination. The patient does not have to come back at a later date. The present invention also provides high resolution imaging of not only the internal parts of the eye, but all aspects of ocular anatomy, such as the eye lids and surrounding area. Finally, the present invention allows the eye care practitioner and his or her staff to employ their existing skills for using the conventional slit-lamp rather than having to master a whole new procedure such as found in prior art devices. It is clear that the present invention would render visual recording of eye examinations much more economical

and therefore much more predominant, thereby greatly increasing the quality of care eye practitioners can offer their patients.

DISCLOSURE OF THE INVENTION

It is an object of this invention to provide a device which converts pre-existing eye examination units such as converging optics slit lamps into visual recording eye examining units that may be used for videographic and angiographic examination.

It is another object of this invention that the device be highly portable and that the device can be quickly attached to and removed from pre-existing eye examination units.

It is still a further object of this invention that the device be able to provide instantaneous, real time, high resolution imaging of all aspects of ocular anatomy.

It is an object of this invention to provide a visual recording eye examining unit which is far more economical than hereto known in the art.

Therefore, a device that converts pre-existing eye examination units such as converging optics slit lamps into visual recording eye examining units is provided. The device generally comprises an adapter member attachable to the viewing element of a slit-lamp and a camera attached to said adapter member.

One embodiment of the adapter comprises a body with a front and rear aperture. The front aperture is formed to matingly receive an eye piece of an eye examining unit and the rear aperture is formed to receive a camera lens.

An alternate embodiment of the adapter comprises a clamp member and a camera frame member pivotally connected to said clamp member with a spacer and filter element positioned between the clamp member and frame member.

Another embodiment of the adapter comprises a viewing tube connected to a head portion and having a first line of sight. A prism positioned in the head portion directs said first line of sight to a second line of sight.

DESCRIPTION OF THE DRAWINGS

Figure 1 is a perspective view of a conventional slit lamp examination unit.

Figure 2 is an exploded view of a preferred embodiment of the invention.

Figure 2(a) is an illustration of how the embodiment of Figure 2 may be rotated with respect to the slit lamp.

Figure 3 is a side view and a partial cut-away view of a second preferred embodiment of the invention.

Figure 4 is a schematic view of the second preferred embodiment of the invention, illustrating lenses and a penta prism.

Figure 5 is an cross sectional view of a third preferred embodiment of the present invention.

Figure 6 is perspective view of the third preferred embodiment of the present invention.

Figure 7 is a side view and partial cut-away view of a fourth preferred embodiment of the present invention.

Figure 8 is a cross sectional view of a fifth preferred embodiment of the present invention.

Figure 9 is a perspective view of the exciter filter use in the present invention.

Figure 10 is a perspective view of a sixth preferred embodiment of the present invention.

Figure 11 is a front view of a sixth preferred embodiment of the present invention.

Figure 12 is a side sectional view of a sixth preferred embodiment of the present invention.

Figure 13 is an exploded perspective view of a seventh preferred embodiment of the present invention.

Figure 14 is a sectional side view of the adapter shown in Figure 15.

Figure 15 is an exploded perspective view of an alternate embodiment of the adapter shown in Figure 13.

BEST MODE FOR CARRYING OUT THE INVENTION

The present invention provides an apparatus for converting a conventional eye examination unit **1** as seen in **FIG. 1**, into a novel and advantageous method of photographing or video taping an eye under examination. A typical eye examination unit **1** which will be used with the present invention is a slit lamp **2** similar to the apparatus shown in **Fig. 1**. However, it is intended that the invention be employable with all eye examination devices having a viewing element **3** which includes an eye piece **5** through which the examiner views the eye of the patient. Besides slit lamp **2** seen in **FIG. 1**, such eye examination devices may include operating microscopes, caratometers, or bio-microscopes.

In general, the invention (one embodiment of which is shown in **FIG. 1** as **75**) will adapt a camera **7** for use with the eye examination unit **1**. The term "camera" as used herein is intended to include all visual recording devices, including photographic cameras or still cameras, conventional video cameras, micro-video cameras, and digital cameras (such as "CCD" cameras, "frame grabbers" or "computer cameras"). The use of digital cameras will allow the invention to interface with existing software programs that aid in the examination of the eye and the diagnosis of eye disorders. At present, the only way to interface with such

software is to acquire very specialized and expensive videographic equipment specifically designed for this purpose.

It will be understood that since the term "camera" is being used in its broadest sense, the invention is also intended to include whatever type of camera mount is needed to interface the camera with the rest of the invention. While specific embodiments may discuss "C-mount" or "CS-mount", those embodiments could comprise whatever camera mount is necessary to utilize the camera of interest.

Slit lamp 2 seen in FIG. 1 includes a light source 87 providing light which is reflected off of mirror 88 into the eye of the patient. A viewing element 3 such as binocular unit 8, allows the eye examiner to magnify and view sections of the eye in great detail. Binocular unit 8 includes an eye piece 5 positioned in eye piece receptacle 10. As shown in Fig. 1, eye piece 5 is removable from eye piece receptacle 10. Camera adapter 75 does not form part of conventional slit lamp 2, but rather is part of the present invention which will be explained in greater detail later in this specification.

FIG. 2 illustrates a preferred embodiment of the present invention. Camera adapter 12 generally comprises a clamp member 14, a spacer element 21, and a camera frame member 38 which will be pivotally connected to spacer element 21 by way of pivot pin 23. Clamp member 14 will have clamp aperture 15 which is sized to slide over the outer diameter of eye piece receptacle 10. Rather than clamp member 14 forming a closed ring around clamp aperture 15, clamp member 14 has two flanges 16 which provide a means for slightly opening and closing clamp aperture 15. In this manner, tightening screw 17 can be loosened to allow clamp member 14 to slide over eye piece receptacle 10 and then tightening screw 17 can be tightened such that clamp member 14 firmly grasps eye piece receptacle 10. Also positioned

on clamp member 14 is threaded mounting aperture 18. Mounting aperture 18 will allow a small, typically 3 inch, liquid crystal display (LCD) screen (not shown) to be mounted on clamp member 14. When this embodiment is used with a video or digital camera 7, the LCD screen will allow the eye examiner to see what is being recorded by the camera 7. If the position of the patient's eye or the slit lamp 2 needs to be adjusted, the eye examiner has a ready visual reference by which to do so.

Spacer element 21 is generally of the same shape as clamp member 14 and will be positioned against clamp member 14. Spacer element 21 will also have pinning aperture 22 for receiving pivot pin 23. Pivot pin 23 will engage frame member 38 as mentioned above and explained in greater detail below. Spacer element 21 includes spacer aperture 24 which will be positioned substantially in line with clamp aperture 15. Spacer aperture 24 is designed to allow eye piece 5 to engage spacer element 21 while maintaining a clear line of sight through spacer element 21. Spacer aperture 24 will be sized such that eye piece ring 6 will fit into spacer aperture 24 and rest securely in spacer element 21, eye piece ring 6 will be prevented from moving farther rearward by filter channel 30 (whose function is explained below).

Those skilled in the art will recognize that the combined thickness of spacer element 21 and clamp member 14 will be equivalent to the distance "a" that the eye piece 5 normally extends from eye piece receptacle 10. In this manner, the eye piece 5 used in conjunction with the invention will have the same focal distance as when the eye piece 5 is positioned directly in the eye piece receptacle 10 in the conventional manner as illustrated by eye piece 5 that has not been removed in **FIG. 2**.

A filter element 28 will be removably positioned within camera adapter 12. Filter element 28 will most typically be used in conjunction with angiography procedures such as

previously described. In the embodiment shown in **FIG. 2**, filter element **28** comprises a filter slide **31** having two filter lenses **32**, with each filter lens **32** being of a different color. Filter lenses **32** will function as barrier lenses with one filter lens being yellow for fluorescein angiography and one lens being black for ICG angiography. Filter slide **31** will slidingly engage channel **30** which is formed in spacer element **21** and thereby allow filter lenses **32** to be selectively interposed between camera lens **44** and eye piece **5**. It will be understood that while 2 filter lenses are shown, a single filter lens could also be employed in filter slide **31**. Additionally, while this embodiment of the invention discloses filter lenses **32** between camera lens **44** and eye piece **5**, it will be understood that filter lenses **32** could be positioned anywhere between the patient's eye and camera **7** and still carry out its intended function.

A central bore hole **35** will be formed through clamp member **14** and continue into spacer element **21**, but not through spacer element **21**. Central bore hole **35** in spacer element **21** will be threaded in order to engage screw **36** which passes through clamp member **14** and terminates in spacer element **21**. It will be seen from **FIG. 2** that screw **36** holds clamp member **14** and spacer element **21** securely together as a unit. When clamp member **14** and spacer element **21** are secured with screw **36**, eye piece **5** will be capable of being inserted through aperture **15** with friction between eye piece ring **6** and the inner diameter of spacer aperture **24** being sufficient to hold eye piece **5** in place. A plurality of pin holes **34** will also pass through clamp member **14** and partially penetrate spacer element **21**. Stabilizer pins **33** will be positioned in pin holes **34** to insure that there is no rotation between clamp member **14** and spacer element **21**.

A frame member **38** will form the rearmost portion of camera adapter **12**. Frame member **38** includes a shell portion **39** which is sized to fit against clamp member **14** and

enclose spacer element 21 and filter element 28. Frame member 38 will also have a plurality of camera extension legs 40 which position camera ring 43 a fixed distance from shell portion 39. Extension legs 40 will have threaded ends 41 engaging shell portion 39 and screw driver heads 42 on the opposite ends. A camera lens 44 will be positioned between shell portion 39 and camera ring 43 and a camera 7 will engage camera lens 44 such that camera 7 is securely fixed to camera adapter 12. In the embodiment shown, camera ring 43 will have internal threads 47 to engage camera lens 44. Camera lens 44 will protrude somewhat beyond camera ring 43 such that camera 7 may be attached thereto. Typically, camera 7 will have a conventional "C-mount" or "CS-mount" for engaging camera lens 44. However, it is envisioned that the invention could be adapted for used with any type of camera mount.

Frame member 38 will also be pivotally connected to spacer element 21 by way of pivot pin 23 engaging pivot hole 45 such that frame member 38 may swing to the side in a 180° arc on spacer element 21. Frame member 38 will have bridge portion 46 which strengthens frame member 38, but still allows frame member 38 to pivot without being obstructed by filter element 28. As illustrated in FIG. 2(a), this configuration allows the frame member 38 (with camera 7 attached thereto) to be easily pivoted to the side so that the eye examiner may look though spacer aperture 24 in spacer element 21 (when filter slide 31 is not inserted into filter element 28) and see directly into eye piece 5.

Those skilled in the art will understand the significant advantages of the present invention when combined with conventional slit lamps 2. When an examiner desires to use slit lamp 2 in the conventional manner, frame member 38 may be pivoted to the side and the eye examiner views the eye through eye pieces 5 as in the typical examination. If the eye examiner desires to record what he is viewing, he may simply pivot the frame member 38 (and thus

camera 7) against clamp member 14. In this manner, shell portion 39 encloses spacer element 21 such that camera lens 44 is next to spacer element 21. Thus camera 7 is in line with eye piece 5 and in a position to begin recording.

Additionally, when the camera 7 is pivoted away from clamp member 14, camera 7 can be used for recording areas other than internal sections of the eye. For example, the entire slit lamp apparatus 2 could be pivoted such that camera 7 could focus on the patient's face without viewing through eye piece 5. This allows the eye examiner to record the external features of the patient's eyes such as the condition of the eye lids and areas surrounding the eye. These advantages are in addition to the angiography applications to which the present invention is well suited. Those skilled in the art will appreciate the present invention, when employing filter lenses 32, allows a conventional slit lamp found in virtually every eye care facility to be cheaply and quickly converted into an angiography examination device.

An second embodiment of the invention is seen in FIG. 3. In this embodiment, camera adapter 49 comprises a viewing tube 50, the outer diameter of which is sized to engage the inner diameter of an eye piece receptacle 10 (such as seen in FIG. 1), a head portion 51, and a neck portion 52. While FIG. 1 illustrates an alternate adapter embodiment which is discussed below, it will be understood that the present embodiment of FIG. 3 engages viewing tube 50 with eye piece receptacle 10 in the same manner as shown in FIG. 1. The lens 61 in viewing tube 50 will be positioned such that the image being viewed (a patients eye) will be focused on a prism 53 inside of head portion 51.

Head portion 51 is a hollow structure in which prism 53 will be positioned. As best seen schematically in FIG. 4, prism 53 is a penta prism which will serve to redirect a first line of sight 54 parallel to viewing tube 50 to a second line of sight 55 running parallel to neck

portion **52**. Light will enter viewing tube **50** along first line of sight **54** and pass through front face **64a** of prism **53**. Light will then be reflected off of rear face **64b** to top face **64c** of prism **53** and then exit through lower face **64d**. These multiple reflections inside of prism **53** will serve to avoid a right-left inversion or the production of a mirror image as viewed from second line of sight **55**.

As the image being viewed is directed along the second line of sight **55**, it passes through a filter element **57**, an iris **60**, and two additional lenses **62** and **63** which are positioned in neck portion **52**. The lens arrangement in neck portion **52** insures that the image will be properly focused on a camera **7** which will be positioned at the bottom of neck portion **52** (see **FIG. 3**). The spacing of the lenses in this embodiment can be seen in **FIG. 4**. Lens **61** will be a lens such as Edmond Scientific E32963 20D 60F. Lens **61** will be a distance **b** from prism **53**, which will be a prism such as Edmond Scientific E31051 20 FACE. Lens **62** will be a lens such as Edmond Scientific E32915 18D 80F and will be positioned a distance **c** from prism **53**. Lens **63** will be a lens such as Edmond Scientific E32913 18D 50F and will be positioned a distance **d** from lens **62**. In the embodiment shown if **FIG. 4**, **b** is equal to 23mm, **c** is equal to 52mm and **d** is equal to 28mm. While this embodiment has been described in terms of specific lenses spaced at specific distances, those skilled in the art of optics will understand that many different lenses can be used and the spacing will vary according to the lens used. The spacing will vary to insure that the lens of camera **7** is the proper focal point of second line of sight **55**.

As previously mentioned, the camera adapter **49** shown in **FIG. 3** will have a filter element. Filter element **57** is illustrated as having black lens **58a** for ICG angiography, yellow lens **58b** for fluorescein angiography, and clear lens **58c** for non-angiographic viewing. Filter

element 57 will slidingly engage neck portion 52 such that the lenses 58 can selectively be moved into the line of sight 55.

To provided a convenient means for attaching and detaching camera 7, a conventional CS-mount 59 will be positioned on the bottom of neck portion 52. An iris 60 and filter element 57 are also positioned in neck portion 52. Iris 60 will regulate the amount of light being received by camera 7 depending on the application in which the invention is being used. As with the previous embodiment, the function of filter element 57 in conjunction with angiography procedures is a great advantage over the prior art.

A third embodiment can be seen in FIG. 5. In this embodiment, camera adapter 66 comprises a body member 67 with front aperture 68 and rear aperture 71. Front aperture 68 is formed with shoulders 69 such that it may matingly receive conventional eye piece ring 6 such that eye piece 5 is held firmly in place in body member 67. It will be understood that the embodiment of FIG. 5 is similar to that of FIG. 2 in that both embodiments employ the eye piece 5 from a conventional eye examination unit. Rear aperture 71 is sized such that it may receive a conventional camera lens 70. However, it is intended that rear aperture 71 could be sized to accommodate any type of lens and camera combination. As best seen in FIG. 6, adapter 66 will have a broken section 72 and tightening screw 73. This will allow adapter 66 to securely engage camera lens 70 and eye piece 5. Adapter 66 will also have a mounting aperture 74 for receiving a small LCD screen as described in the first embodiment. When adapter 66, eye piece 5 and camera 7 are joined as a unit as seen in FIG. 6, eye piece 5 may be inserted into an eye piece receptacle and video recording of the eye examination may proceed. While not shown in the figures, adapter 66 could also include a slidable filter element. Such a filter element could be constructed similar to filter element 28 shown in FIG.

2. If the rear of adapter 66 is extended, a slot for the sliding filter element could be formed therein such that the filter element would be positioned between eye piece ring 6 and lens 70. This arrangement would allow adapter 66 to be used in angiography procedures.

A fourth embodiment of an adapter member 75 can be seen in Fig. 7. As in the second embodiment seen in FIG. 3, the fourth embodiment illustrated in FIG. 7 has a viewing tube 76 attached to a head portion 77 and a prism 80 positioned inside of head portion 77. Viewing tube 76 is substantially the same as viewing tube 50 disclosed in FIG. 3. However, prism 80 does not perform the same function as prism 53 disclosed in FIG. 3. Prism 80 is a beam splitting prism that simultaneously directs the line of sight from viewing tube 76 in two different directions. Beam splitting prism 80 directs a first line of sight 78 toward fixed eye piece 81 which is attached to the rear of head portion 77. Through fixed eye piece 81, the eye examiner is able to directly view the eye under examination. Simultaneously, beam splitting prism 80 directs a second line of sight 79 in the direction of camera 7. In this manner, the invention allows the examiner to directly view the eye at the same time camera 7 records what the examiner is viewing. Neck portion 82 will contain lenses spaced at intervals necessary to have second line of sight 79 focus on camera 7. Iris 83 will also be positioned on neck portion 82 in order to regulate the amount of light being received by camera 7.

A fifth embodiment of the invention, camera adapter 95, can be seen in FIG. 8. Camera adapter 95 generally comprises viewing tube 96 and adapter body 100. Viewing tube 96 is again substantially the same viewing tube as disclosed in the embodiments of FIGS. 3 and 7. Adapter body 100 further comprises front section 102, mid-section 103, iris section 104, and rear section 105. Front section 102 will be threadedly connected to viewing tube 96 and mid-section 103. Mid-section 103 will also be connected to iris section 104, which will contain

iris **101** which will adjust the amount of light reaching camera **7** as in the previously described embodiments. Iris section **104** will engage rear section **105** which will have threads **106** for attachment to conventional camera mount.

Front section **102** and rear section **105** will contain lenses **97** and **98** respectively. As those skilled in the art will appreciate, lenses **97** and **98** may be any number of conventional lenses whose spacing may vary depending on the particular lenses used. In the embodiment shown, lenses **97** and **98** are 33 diopter achromatic and 37 diopter achromatic lenses respectively. The present invention is not considered limited to any particular type or number of lenses, the only requirement being that the lens arrangement focus the image viewed on the lens of camera **7**.

A sixth embodiment of the present invention is illustrated in **FIGS. 10-12**. **FIG. 10** shows an adapter member **110** which generally comprises a body member **111**, a rear plate **120**, a camera sleeve **121** and a filter slide **119**. Camera **124** is shown in phantom just prior to its insertion to camera sleeve **121**. While the camera shown in **FIG. 10** is a 17mm diameter, ½" CCD micro-camera, numerous alternated camera's could be used with camera sleeve **121** being sized accordingly.

Body member **111** in turn further comprises a clamp ring **115**, a block **113**, a pair of flanges **116** (only one of which is visible in **FIG. 10**), and a forward plate **112**. As best seen in **FIG. 12**, clamp ring **115** will be formed integrally with block **113** and flanges **116**. A tightening screw **117** will engage flanges **116** allowing clamp ring **115** to close on an eye piece receptacle **10** (see **FIG. 1** illustrating an eye piece receptacle **10**).

FIG. 11 is a cross-sectional view of the present embodiment illustrating the manner in which the camera adapter **110** will be mounted on eye piece receptacle **10**. In **FIG. 11**, the eye

piece receptacle **10**, eye piece **5**, and camera **124** are all shown in phantom. The sectional view of **FIG. 11** also illustrates how clamp ring **115** is not attached to forward plate **112** along the entire length of forward plate **112**. Rather clamp ring **115** is only attached to forward plate **112** along the upper portion of clamp ring **115**. The lower portion of ring clamp **115** and flanges **116** are not connected to forward plate **112**. This configuration allows clamp ring **115** to collapse slightly and securely grip eye piece receptacle **10** as flanges **116** are brought together.

Viewing **FIGS. 10** and **11**, it can be seen that filter channel **118** is formed in block **114** and forward plate **112**. Filter channel **118** is sized to allow filter slide **119** to be removably positioned in filter channel **118**. When filter slide **119** is positioned in filter channel **118**, the filter lens will be interposed between camera **124** and eye piece **5**. As discussed above, filter slide **119** will allow camera adapter **110** to be used in conjunction with fluorescein and ICG angiography procedures.

As best seen in **FIG. 10**, rear plate **120** will be attached to forward plate **112** by screws **123**. Also, a set screw **122** will engage camera sleeve **121** in order to securely hold camera **124** in place when camera **124** is inserted into camera sleeve **121**. Block **113** will have a threaded aperture **114** to accommodate various camera accessories, such as a "hot-shoe". In a preferred embodiment, camera adapter **110** will be constructed of a light weight flexible metal such as conventional "aircraft" aluminum. However, it is envisioned that camera adapter **110** could be constructed of a wide range of suitable materials.

A seventh embodiment of the present invention is illustrated in **FIGS. 13-15**. **FIG. 13** shows an adapter member **130** which generally comprises a body member **132**, a rear plate **134**, a camera sleeve **135** and a filter slide **137**. Camera **7** is shown just prior to its insertion

to camera sleeve **135**. While the camera shown in **FIG. 13** is a 17mm diameter, ½" CCD micro-camera, numerous alternated cameras could be used with an alternative camera sleeve **135** being sized accordingly or with an alternative camera mounting systems as described below in conjunction with the description of **FIG. 15**.

Body member **132** in turn further comprises a back wall **136** in which a filter channel **138** is formed. Back wall **136** also contains aperture **144** which forms a line of sigh between eye piece **143** and camera 7. Body member **132** further comprises an adjusting slot **133** which will accommodate a tightening screw **141**, while the tightening screw **141** will engage an eye piece retaining member **140**. As seen in **FIG. 13**, retaining member **140** is a ring shaped body having a center aperture **142** which is sized to receive conventional slit lamp eye piece **143**. The cross sectional view of **FIG. 14** best illustrates how retaining member **140** will securely hold eye piece **143** against back wall **136**. Returning to **FIG. 13**, it will be seen that when tightening screw **141** is loosely threaded into retaining member **140**, retaining member **140** (with eye piece **143** extending through aperture **142**) may be positioned inside of body member **132** with tightening screw **141** engaging adjusting slot **133**. When eye piece **143** is positioned between back wall **136** and retaining member **140**, tightening screw **141** is tightened against adjusting slot **133** to securely maintain eye piece **143** inside body member **132**. It can be seen that adjusting slot **133** allows retaining member **140** to move forward or backward as needed to accommodate eye piece rings **131** of various sizes such as shown on eye pieces **143a** and **143b**.

The embodiment of adapter **130** shown in **FIG. 13** will also comprises a rear plate **134**. Rear plate **134** will include camera sleeve **135** extending from rear plate **134** and camera sleeve **135** will have an internal passage sized to review camera 7. Rear plate **134** also has a threaded

parameter which will engage a threaded surface of body member **132**. However, any conventional method of attachment could be used to connect rear plate **134** to body member **132**. Such methods could include but are not limited to attachment with screws or pins, welding, or simply forming rear plate **134** as an integral part of body member **132** through casting, milling or other means.

The cross-sectional view of **FIG. 14** illustrates the manner in which the camera adapter **130** will be mounted on eye piece receptacle **10** of an eye examining unit such as a conventional slit lamp (see **FIG. 1** illustrating an eye piece receptacle **10**). Once eye piece **143** is secured in adapter **130**, eye piece **143** is inserted into eye piece receptacle **10** and body member **132** slides over the outer shoulder of eye piece receptacle **10** and eye piece receptacle **10** is seated against the inner surface of retaining member **140**. This manner of attachment will be sufficient to maintain adapter **130** in connection with the slip lamp during the course of a normal eye examination procedure.

FIG. 15 illustrates modification of the embodiment disclosed in **FIGS. 13** and **14**. This embodiment allows cameras significantly larger than the ½" CCD micro-camera discussed above to be employed with adapter **130**. Body member **132** includes a retaining member (not shown), adjusting slot **133**, and tightening screw **141** similar to the embodiment of **FIGS. 13** and **14**. However, the embodiment of **FIG. 15** differs in that it also comprises a lens support frame **148** which includes support frame back plate **153** and sliding frame leg **149**. Sliding frame leg **149** will have a somewhat arcuate shape which will conform to the shape of lens **147** in order to provide a more contoured platform on which lens **147** may rest. Support frame back plate **153** will have a conventional camera mount **152** or other suitable means for securing camera **7** and lens **147** to lens support frame **148**. Camera mount **152** will include threads **154**

for engaging camera 7 and while not seen in FIG. 15, will include threads adapted to engage threads 151 of lens 147. To position lens 147 properly against body member 132, support leg 149 will engage channel 150 which is formed in body member 132 and adapted to receive support leg 149. Support leg 149 can then be inserted into channel 150 to the extent necessary to position lens 147 against body 130. While not shown, a set screw or any other conventional means may be used to secure support leg 149 inside of channel 150. In addition to the adapter members disclosed above, FIG. 1 illustrates how the present invention includes a means of positioning a light filter 84 between the eye being examined and the light source 87 used in illuminating the eye. This filter 84 will act as an exciter filter for use in angiography procedures. As previously described, filter 84 filters out all wavelengths of light except that wavelength which excites the fluorescein or ICG dye traveling through the blood vessels of the patients eyes.

In the eye examination unit 1 shown in Fig. 1, exciter filter 84 is positioned between light source 87 and light directing mirror 88. As seen in FIG. 9, exciter filter 84 comprises filter clamp 89, pivoting arm 86 pivotally attached to filter clamp 89, and exciter filter lens 85. By being positioned on pivoting arm 86, exciter filter lens 85 can be placed in the light path when fluorescein or ICG angiography is being performed. Alternatively, exciter filter lens 85 can be removed from the light path when other conventional examinations are being performed with the slit lamp 2. As previously discussed, fluorescein angiography will employ a blue filter lens and ICG angiography will employ a infra-red filter lens. It can be seen that exciter filter 84, when used in conjunction with barrier filters positioned in the camera adapter, converts the conventional slit lamp 2 into an expedient and useful device for performing angiography procedures.

While the present invention includes both embodiments utilizing beam splitting prisms and embodiments not utilizing prisms, those embodiments not utilizing prisms may be more advantageous when performing angiography procedures. The more light that is reflected from the eye to the camera, the more distinct will be the image of the dye illuminated blood vessels. However, when a device uses a beam splitting prism to redirect the light path, a significant fraction of the light will be directed away from the camera. Therefore it is expected that embodiments not utilizing a beam splitting prism will provide a superior image, particularly in low light angiography.

From the above described embodiments, those skilled in the art will recognize the present invention allows an eye examiner to record a straight on or an in-line view of the eye. This in-line view of the eye will allow the retina or rearward area of the eye to be clearly recorded. A camera not positioned in-line with the eye, such as a camera positioned to one side of the eye, will seriously limit what, if any, rearward areas of the eye may be recorded.

Finally, while many parts of the present invention have been described in terms of specific embodiments, it is anticipated that still further alterations and modifications thereof will no doubt become apparent to those skilled in the art. It is therefore intended that the following claims be interpreted as covering all such alterations and modifications as fall within the true spirit and scope of the invention.

CLAIMS

I claim:

1. A portable visual recording eye examining unit comprising:

a. an eye examination device having a light source and a viewing element;

b. an adapter member connectable to said viewing element; and

c. a camera attached to said adapter member.

2. A portable visual recording eye examining device according to claim 1, wherein said adapter member has a light filter element for use in angiography examination.

3. A portable visual recording eye examining device according to claim 2, wherein said filter element is removably positioned between the eye being examined and said camera.

4. A portable visual recording eye examining device according to claim 1, wherein said eye examination unit is a converging optics slit lamp.

5. A portable visual recording eye examining unit according to claim 1, wherein:

a. said viewing element comprises an eyepiece receptacle for a removable eyepiece;

b. said adapter member has a viewing tube that is positioned in said eyepiece receptacle; and

c. said camera is attached to said adapter member.

6. A portable visual recording eye examining unit according to claim 1, wherein:

a. said viewing element comprises a removable eyepiece;

b. said removable eye piece is connected to said adapter member; and

c. said camera is attached to said adapter member.

7. A portable visual recording eye examining unit according to claim 5, wherein a video camera is wired to a display screen allowing the examiner to indirectly view the eye being examined.

8. A portable visual recording eye examining unit according to claim 1, wherein said adapter member comprises:

a. a viewing tube having a line of sight from a fixed eye piece to the eye under examination; and

b. a neck portion having a line of sight from the eye under examination to a camera.

9. A portable visual recording eye examining unit according to claim 8, wherein said adapter further comprises a prism cube beam splitter in the line of sight of said viewing tube and neck portion, producing a simultaneous line of sight from the eye under examination to said fixed eye piece and said camera.

10. A portable visual recording eye examining unit according to claim 1, wherein said adapter member comprises:

a. a clamp member; and

b. a camera frame member pivotally connected to said clamp member.

11. A portable visual recording eye examining unit according to claim 1, wherein said adapter member comprises:

a. an viewing tube having a first line of sight;

b. a prism directing said first line of sight to a second line of sight;

12. A camera adapter for an eye examining unit comprising:

a. a body with a front and rear aperture;

b. said front aperture being formed to matingly receive an eye piece of an eye examining unit;

c. said rear aperture being formed to receive a camera lens.

13. The camera adapter for an eye examining unit according to claim 12, wherein said front aperture has a shoulder and said eye piece has an eye piece ring such that said eye piece ring securely engages said shoulder.

14. The camera adapter for an eye examining unit according to claim 12, wherein said eye piece is the eye piece of a conventional converging optics slit lamp.

15. The camera adapter for an eye examining unit of claim 13 wherein said rear aperture has a micro-camera attached thereto.

16. A camera adapter for an eye examining unit comprising:

a. a clamp member; and

b. a camera frame member pivotally connected to said clamp member.

17. The camera adapter for an eye examining unit according to claim 16, wherein said clamp member has an aperture to grasp the outer diameter of an eye piece receptacle and a tightening member to close said aperture.

18. The camera adapter for an eye examining unit according to claim 17, having a spacer element connected to said clamp member, said spacer element having an aperture adapted to receive an eye piece of an eye examining unit.

19. The camera adapter for an eye examining unit according to claim 18, wherein said spacer element has a pin aperture for receiving a pivot pin.

20. The camera adapter for an eye examining unit according to claim 16, further having a filter element attached thereto.

21. The camera adapter for an eye examining unit according to claim 20, wherein said filter is positioned between said clamp member and said frame.

22. The camera adapter for an eye examining unit according to claim 16, wherein said frame member has a plurality of extension legs and a camera connecting ring attached to said extension legs.

23. A camera adapter for an eye examination unit comprising:

a. an viewing tube having a first line of sight;

b. a prism directing said first line of sight to a second line of sight;

c. a camera mount positioned along said second line of sight.

24. The camera adapter for an eye examination unit according to claim 23, wherein a filter is positioned between said prism and said camera mount.

25. The camera adapter for an eye examination unit according to claim 23, having a fixed eye piece and said prism directing a line of sight simultaneously to said fixed eye piece and said camera mount.

26. A camera adapter for an eye examination unit comprising:

a. a body member forming an aperture to grip an eye piece receptacle;

b. a rear plate connected to said body member;

c. a camera sleeve extending from said rear plate.

27. The camera adapter for an eye examination unit according to claim 26, wherein said body has a flange allowing said aperture to be tightened on an eye piece receptacle.

28. The camera adapter for an eye examination unit according to claim 26, wherein said body has a filter channel formed therein.

29. The camera adapter for an eye examination unit according to claim 26, wherein said body further comprises:

a. a clamping ring;

b. a block formed on said claiming ring;

c. a forward plate connected to said block; and

d. a filter channel formed in said block and forward plate.

30. The camera adapter for an eye examination unit according to claim 29, wherein said clamping ring has a flange attached thereto for tightening said clamping ring on an eye piece receptacle.

31. The camera adapter for an eye examination unit according to claim 29, wherein said camera sleeve has a tightening device adapted for securing a camera in said camera sleeve.

32. A portable visual recording eye examining device according to claim 3, further having a second light filter element removably positioned in a light path between said light source and the eye being examined.

33. An angiography filter assembly for reversibly converting a conventional slit lamp into an angiography examining unit, said angiography filter assembly comprising:

a. a filter lens;

b. a filter arm adapted to removably position said filter lens between a light source on said slit lamp and an eye under examination; and

c. a clamp adapted to secure said filter arm to said slit lamp.

34. An angiography filter assembly according to claim 33 further comprising a barrier filter positioned between an eye under examination and a viewing element of said slit lamp.

35. A camera adapter for an eye examination unit comprising:

a. a body member forming an aperture sized to receive an eye piece of an eye examination unit;

b. a rear plate connected to said body member, said rear plate forming an aperture such that a camera may be operatively connected to said rear plate.

36. The camera adapter for an eye examination unit according to claim 35, wherein said body includes an eye piece retaining member.

37. The camera adapter for an eye examination unit according to claim 35, wherein said rear plate has a camera sleeve attached thereto.

38. The camera adapter for an eye examination unit according to claim 36, wherein said eye piece retaining member is ring shaped and sized to be positionable inside said body.

39. The camera adapter for an eye examination unit according to claim 38, wherein said body has an adjusting slot and a positioning device engages said slot and said eye piece retaining member.

40. The camera adapter for an eye examination unit according to claim 39, wherein said positioning device is a screw member.

41. The camera adapter for an eye examination unit according to claim 35, wherein said body has a filter channel formed therein.

42. The camera adapter for an eye examination unit according to claim 35, wherein said body has a wall positioned between said rear plate and an eye piece retaining member.

43. A camera adapter for an eye examination unit comprising:

a. a body member having a means to receive an eye piece receptacle;

b. a camera connecting means such that a camera may be operatively connected to said body.

44. The camera adapter for an eye examination unit according to claim 43, wherein said body includes an eye piece retaining means.

45. The camera adapter for an eye examination unit according to claim 44, wherein said eye piece retaining means is sized to be positionable inside said body.

46. The camera adapter for an eye examination unit according to claim 44, wherein said body includes a means for adjusting said eye piece retaining member.

47. The camera adapter for an eye examination unit according to claim 43, wherein said body has a filter means connected thereto.

48. A camera adapter for an eye examination unit comprising:

a. a body member forming an aperture sized to receive an eye piece receptacle;

b. a lens support frame connected to said body member.

49. The camera adapter for an eye examination unit according to claim 48, wherein said lens support frame includes a back plate and a support leg connecting said support frame with said body.

50. The camera adapter for an eye examination unit according to claim 49, wherein said back plate forms an aperture for receiving a camera lens.

51. The camera adapter for an eye examination unit according to claim 49, wherein said body has a support leg aperture for slidably receiving said support leg.

52. The camera adapter for an eye examination unit according to claim 49, wherein said back plate contains conventional camera mount.

53. The camera adapter for an eye examination unit according to claim 49, wherein said back plate has a threaded aperture sized to matingly receive the threads of a conventional camera lens.

54. A process for performing angiography using a conventional slit lamp having a light source, a eye piece, and an eye piece receptacle, said process comprising the steps of:

a. positioning an exciter filter on said slit lamp between said light source and an eye under examination;

b. positioning a camera adapter containing said eye piece to engage said receptacle piece receptacle; and

c. positioning a barrier filter between an eye under examination and a camera attached to said camera adapter.

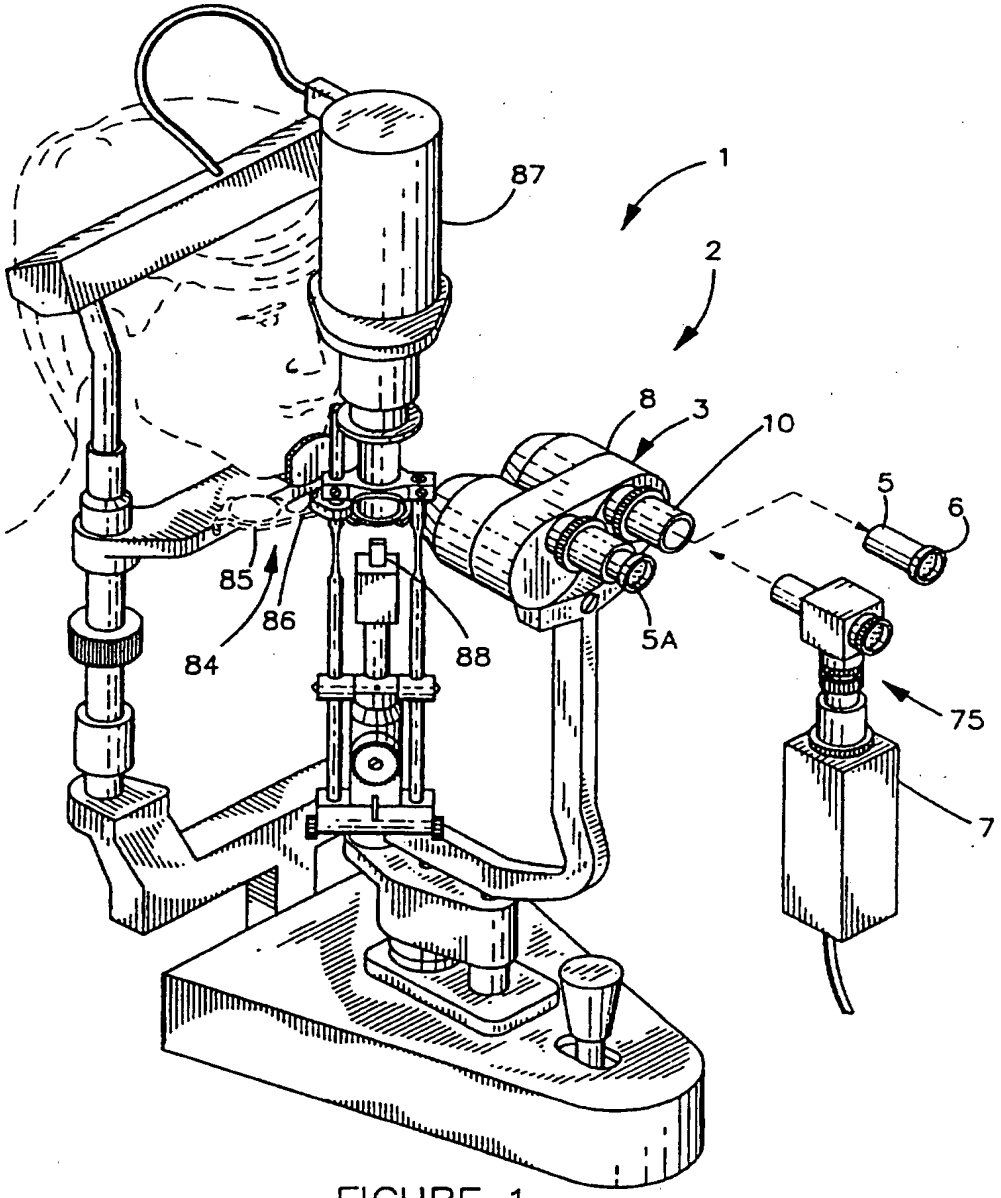

FIGURE 1

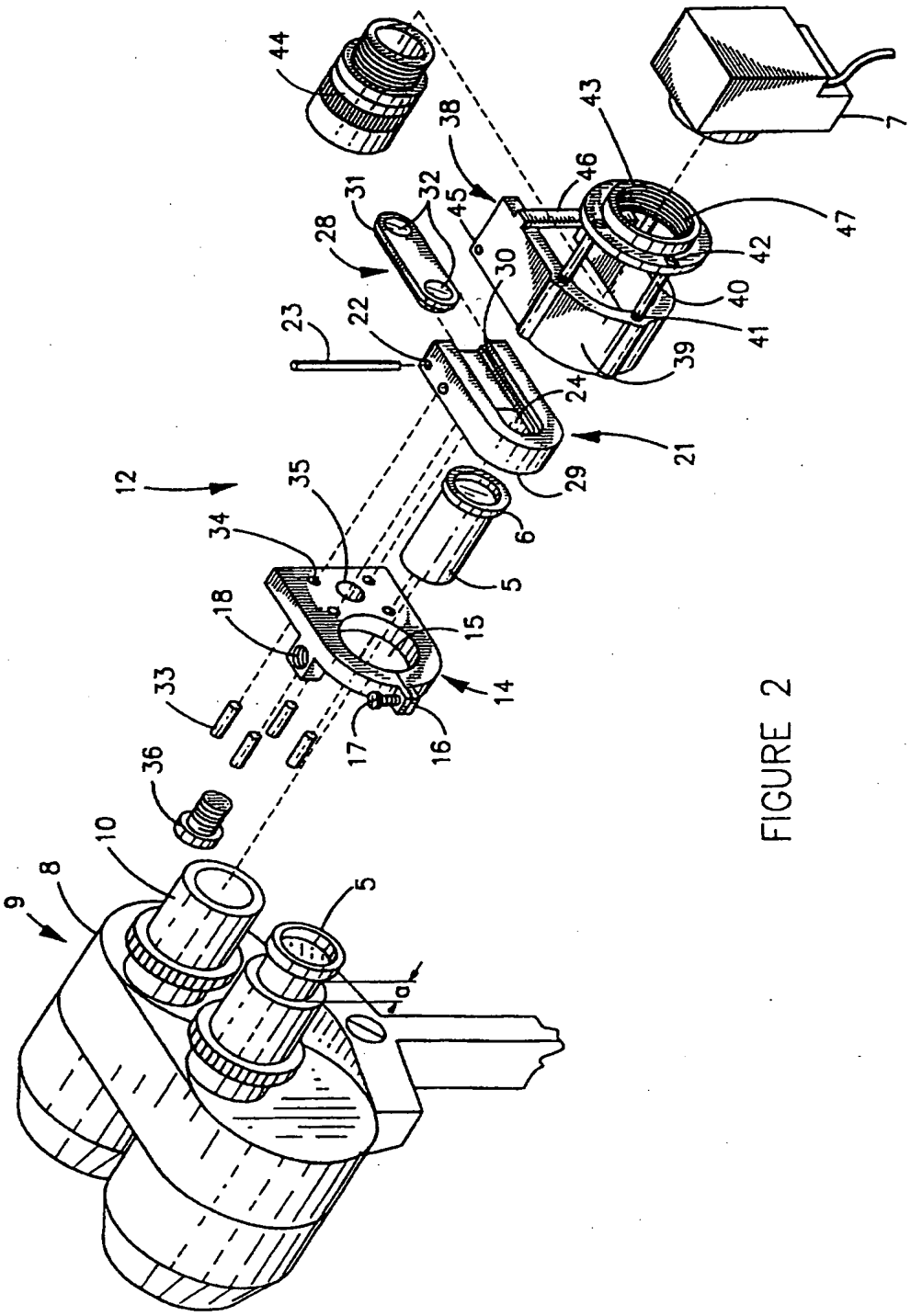
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FIGURE 2

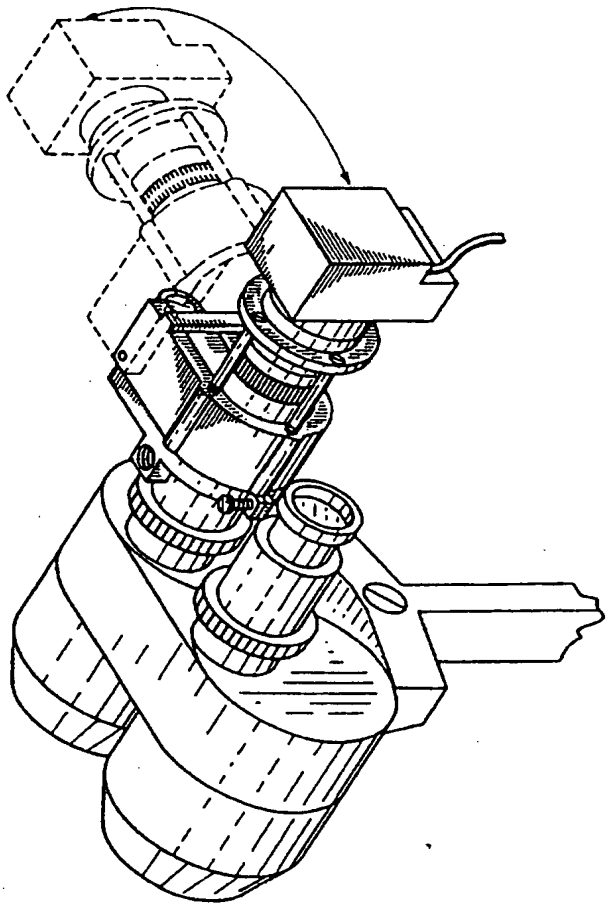

FIGURE 2a

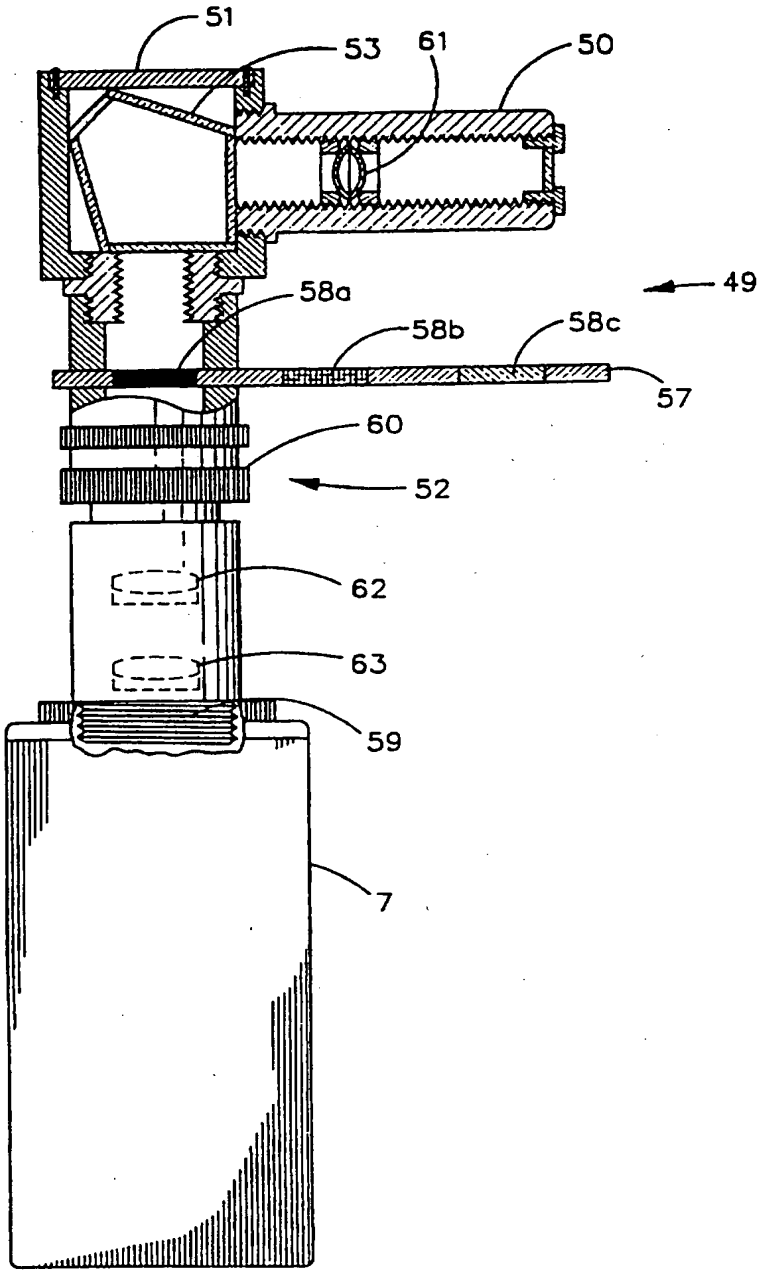

FIGURE 3

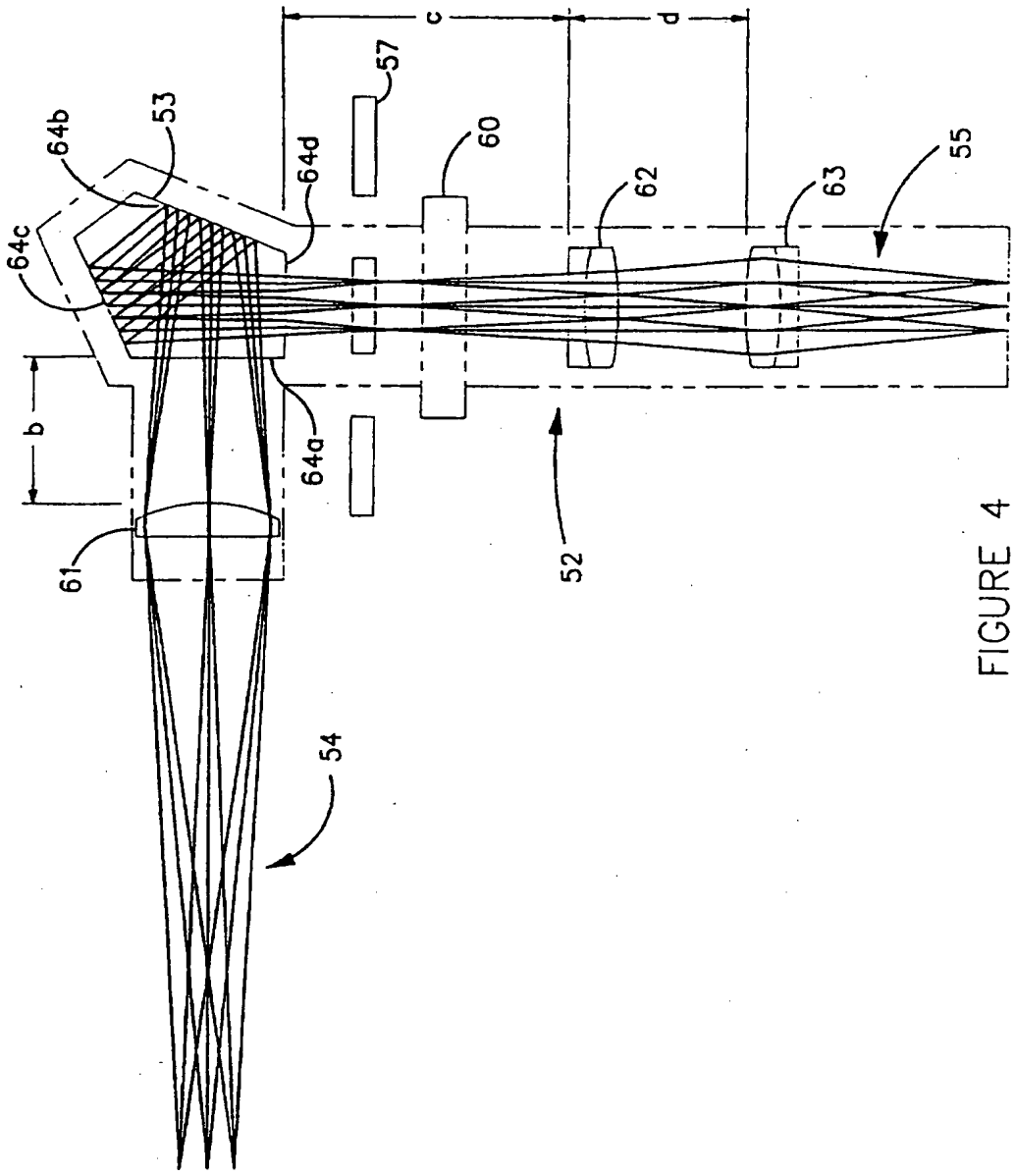

FIGURE 4

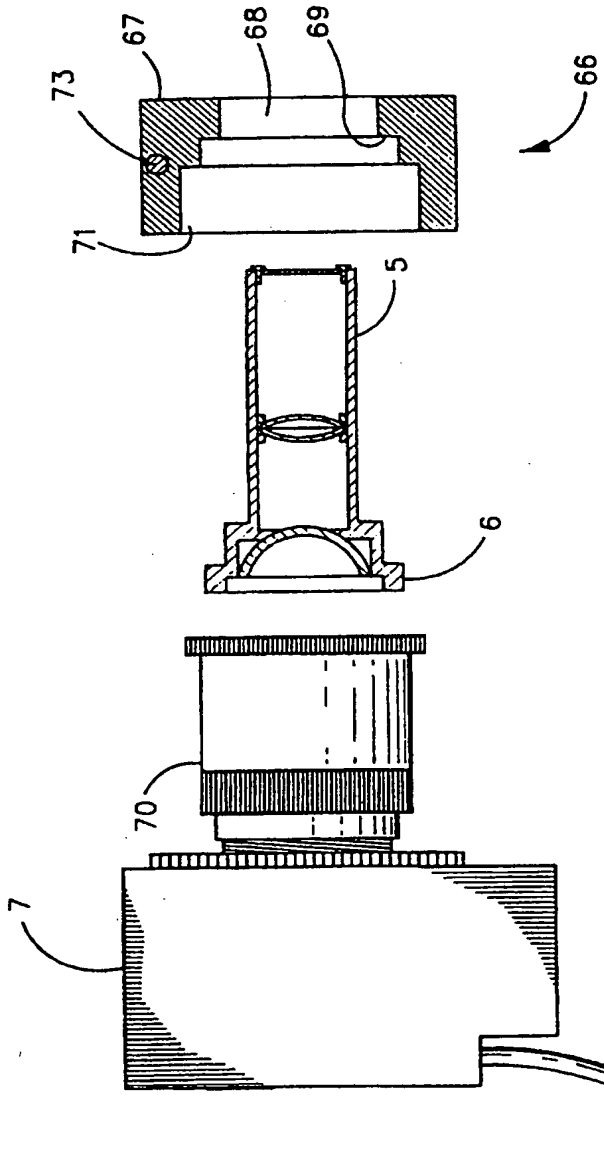

FIGURE 5

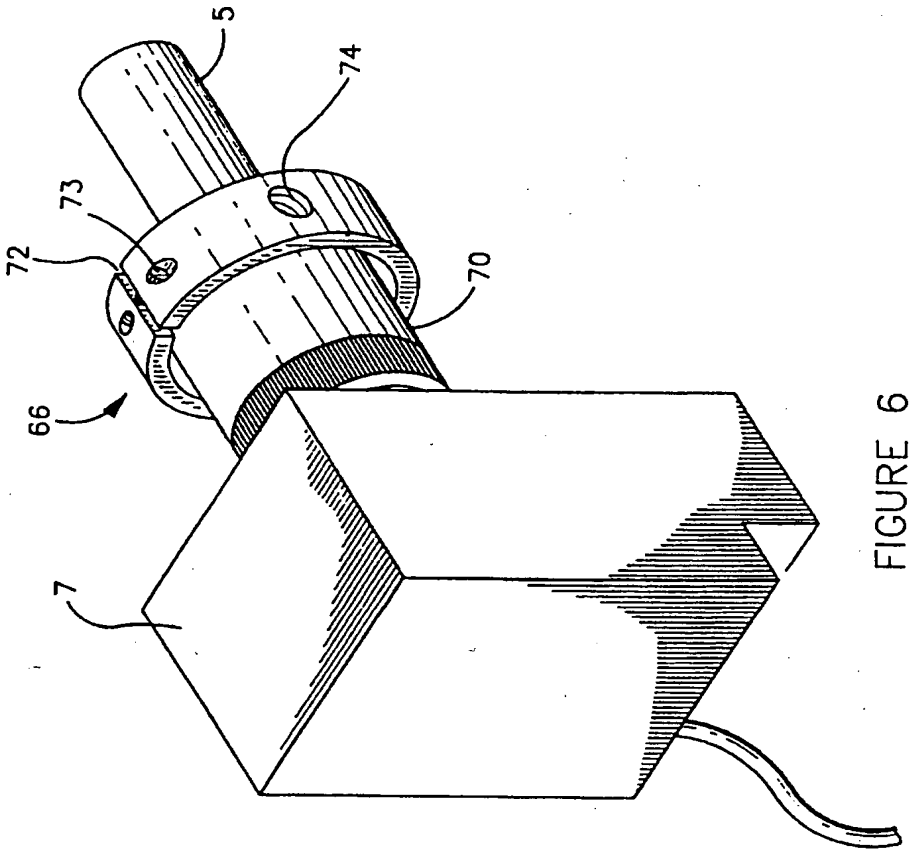

FIGURE 6

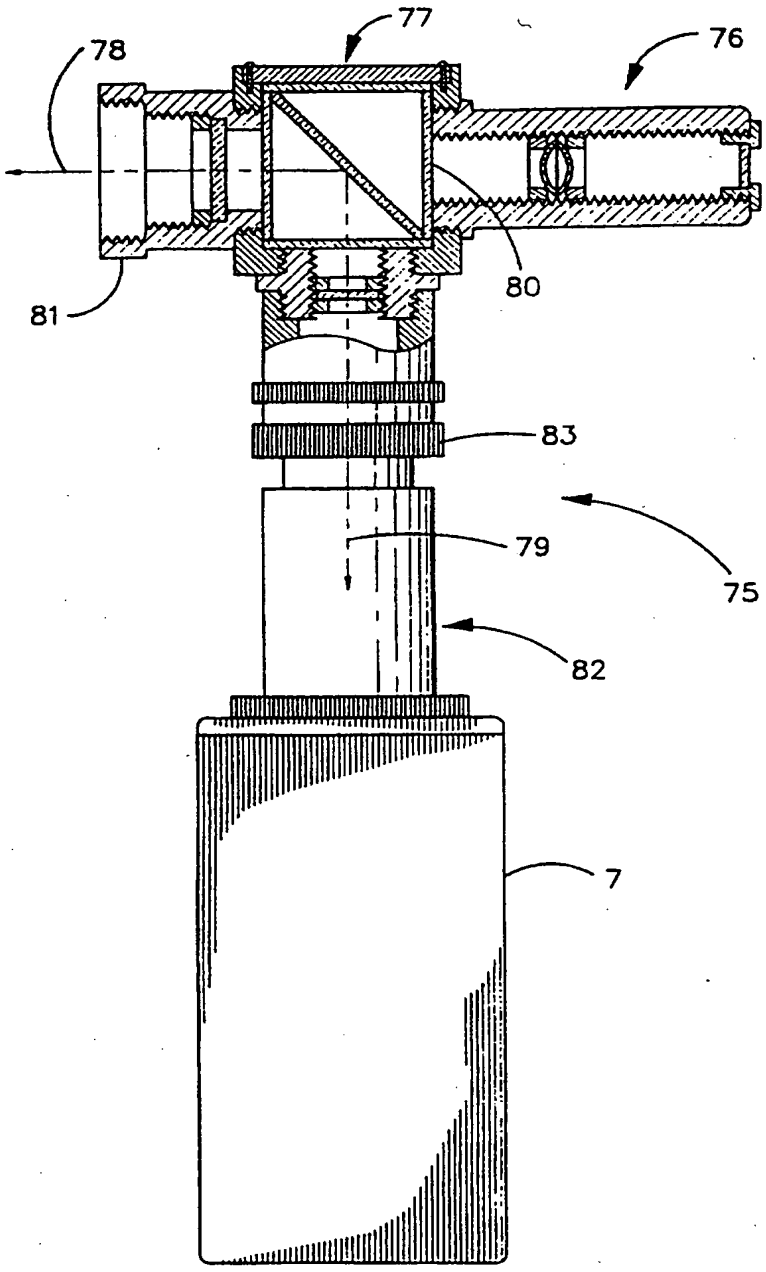

FIGURE 7

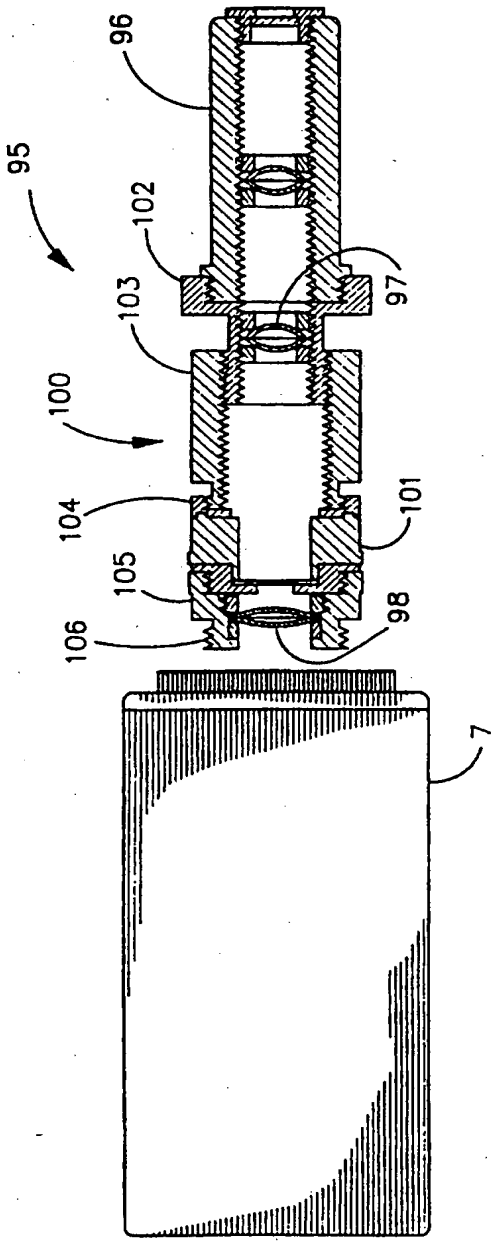

FIGURE 8

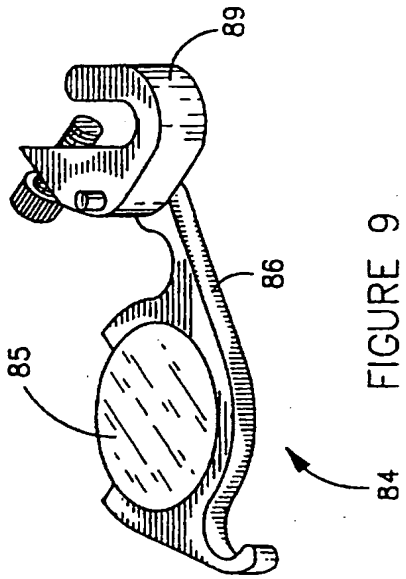

FIGURE 9

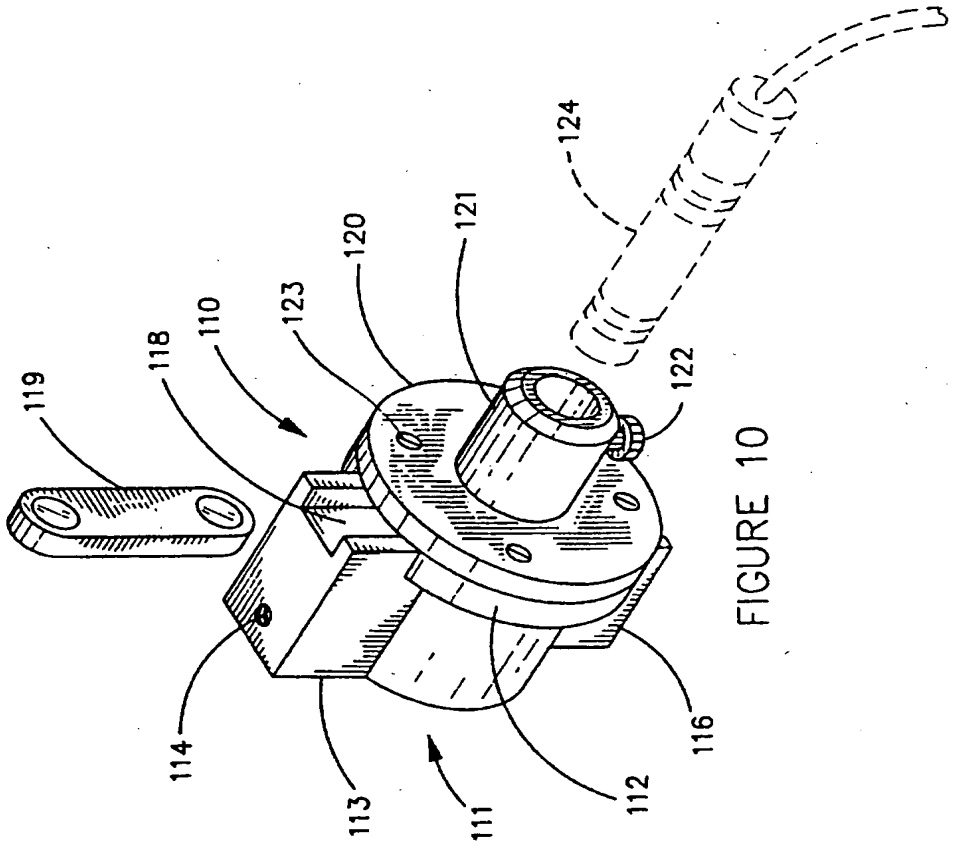

FIGURE 10

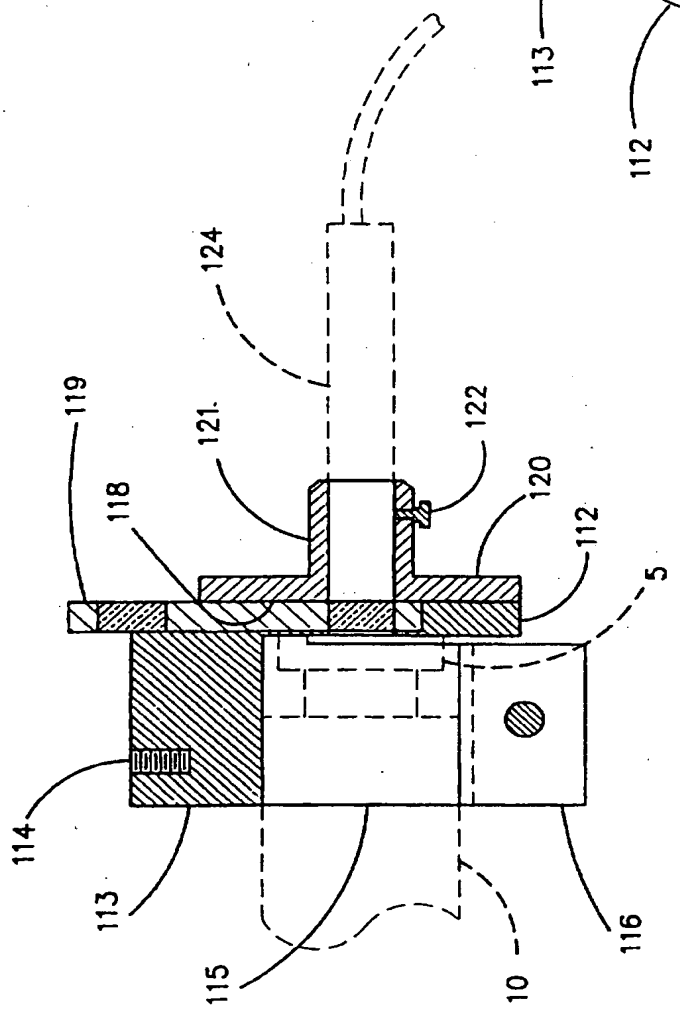

FIGURE 11

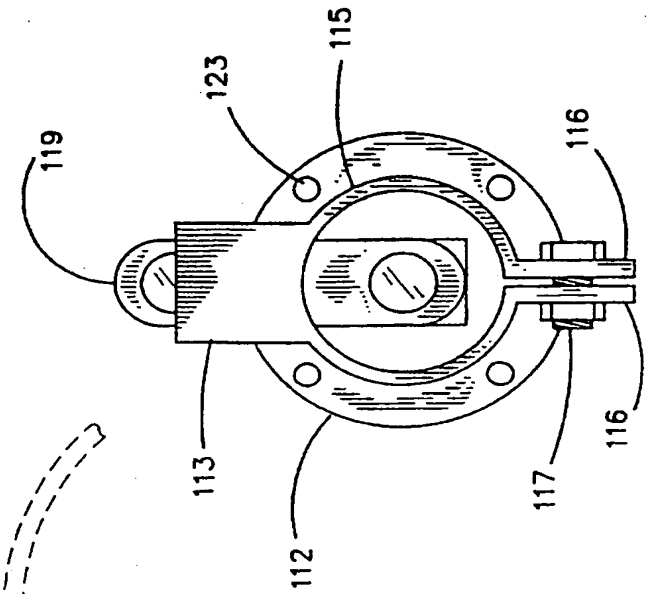

FIGURE 12

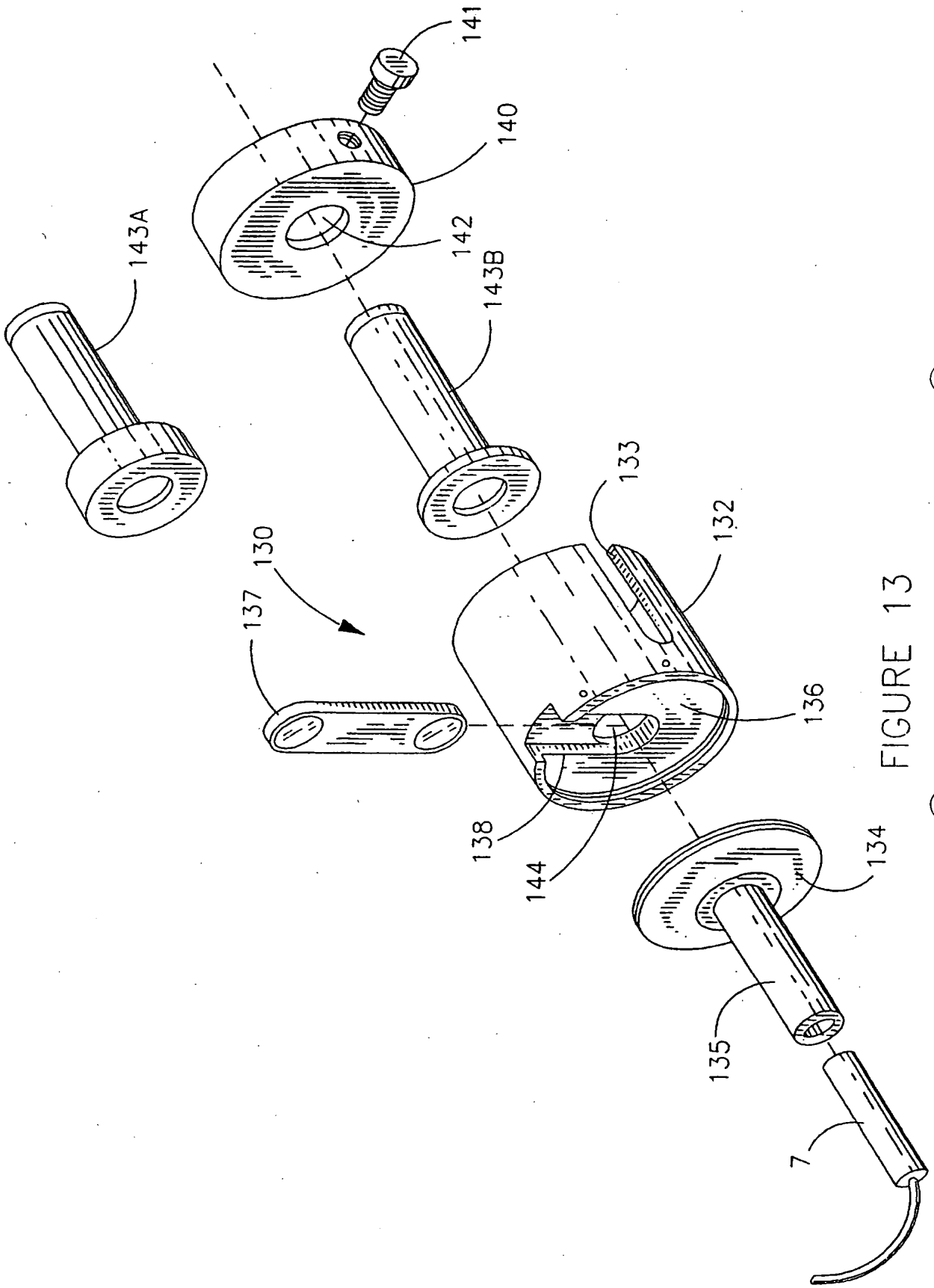

FIGURE 13

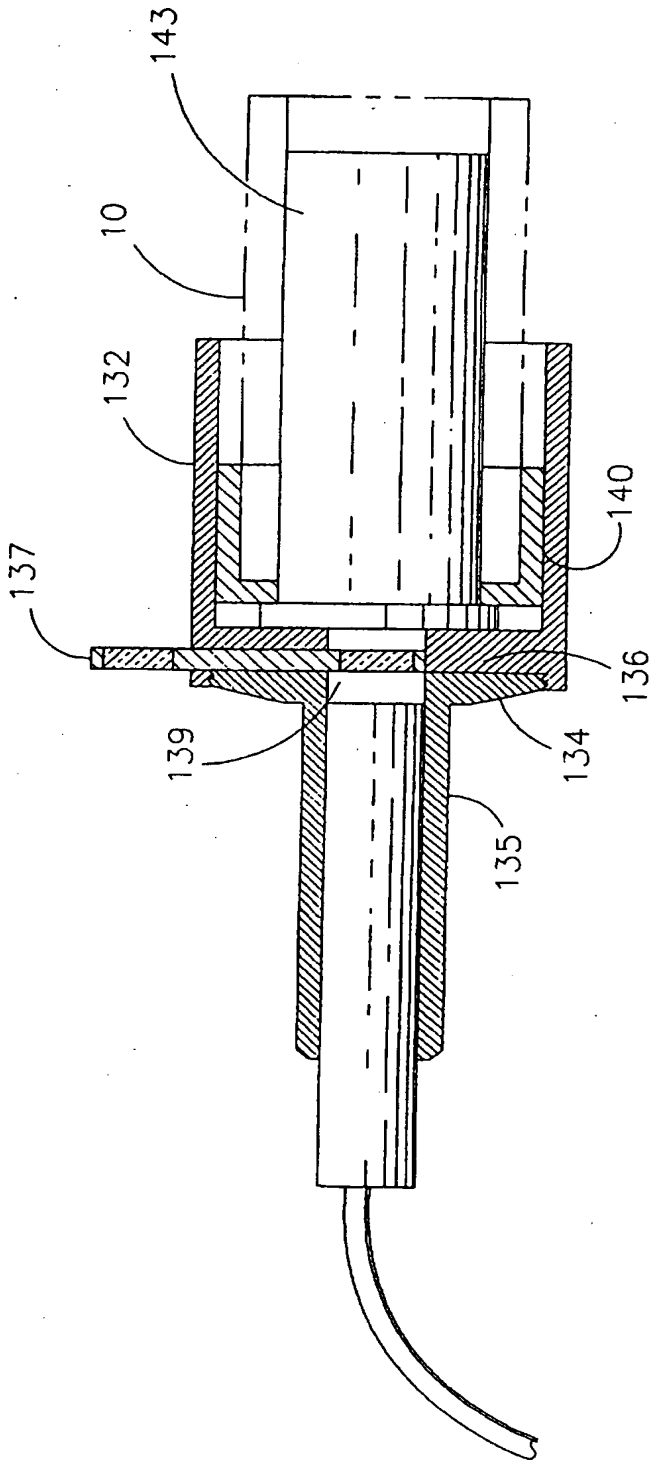

FIGURE 14

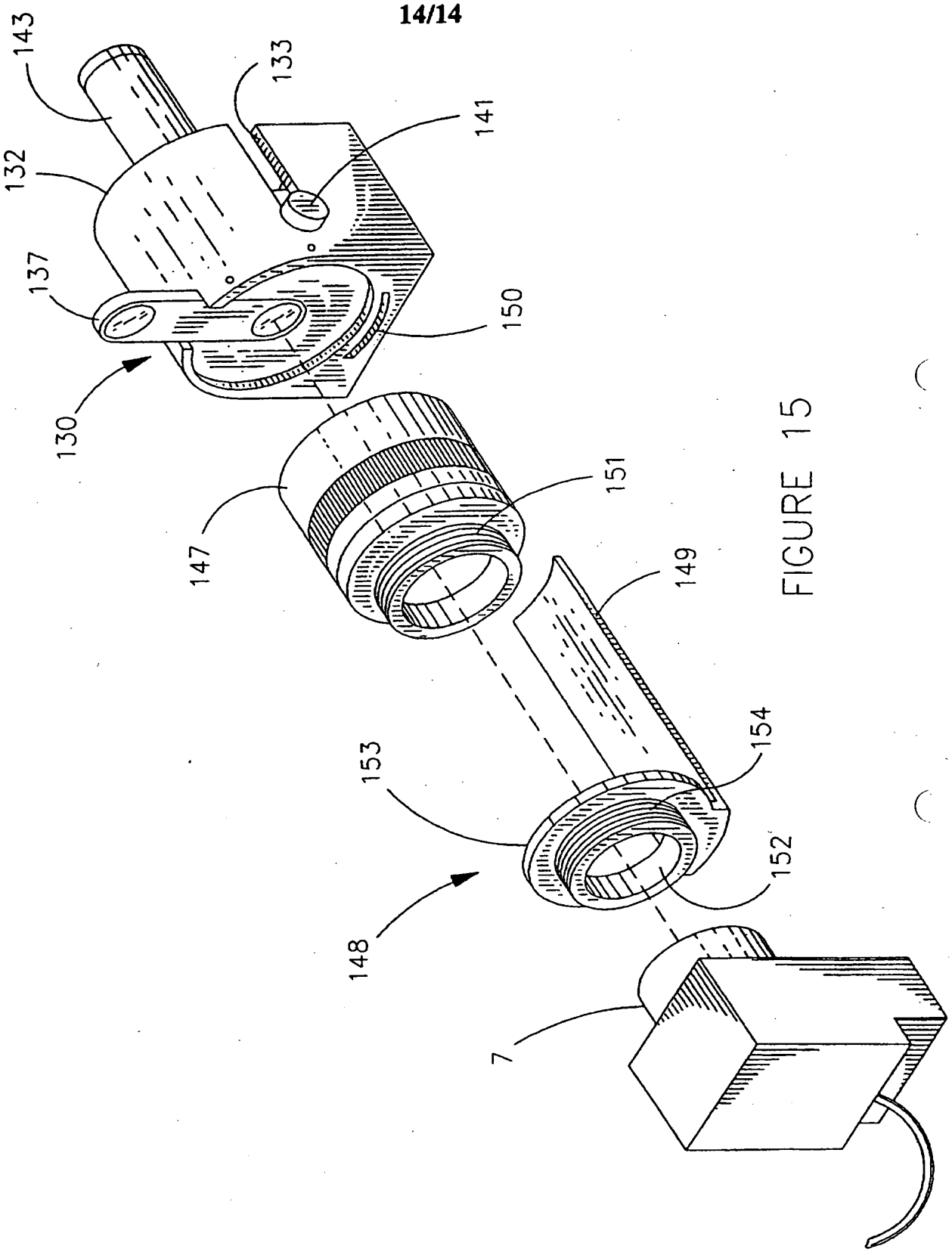

FIGURE 15

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US97/00692

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :A61B 3/00, 3/10, 3/14
US CL :351/200, 206, 216, 245; 396/18
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 351/200, 205, 206, 214, 216, 245; 396/18, 432; 359/363

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

APS
search terms: adapter, camera, eye piece

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3,944,342 A (MARTINEZ) 16 March 1976 (16.03.76), Figs. 1-5, col. 3, line 30 through col. 6, line 63.	1-8, 35-53
X --- Y	US 4,504,129 A (VAN IDERSTINE) 12 March 1985 (12.03.85), see entire document.	1-8,12,16,26 --- 9-11,13-15,18-25,27-31
X	US 5,089,909 A (KLEINBERG) 18 Feb. 1992 (18.02.92), Figs. 2,4, col. 4, line 67 through col. 6, line 21.	35-53
X	US 5,264,928 A (HOWES) 23 Nov. 1993 (23.11.93), see entire document.	23-25

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search 10 JUNE 1997	Date of mailing of the international search report 24 JUN 1997
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. N/A	Authorized officer HUY MAI Telephone No. (703) 308-4874

Form PCT/ISA/210 (second sheet)(July 1992)*

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US97/00692

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5,469,236 A (ROESSEL) 21 Nov. 1995 (21.11.95), see entire document.	10,11

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US97/00692

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

Please See Extra Sheet.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:
1-32,35-53

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US97/00692

BOX II. OBSERVATIONS WHERE UNITY OF INVENTION WAS LACKING
This ISA found multiple inventions as follows:

This application contains the following inventions or groups of inventions which are not so linked as to form a single inventive concept under PCT Rule 13.1. In order for all inventions to be searched, the appropriate additional search fees must be paid.

Group I, claim(s) 1-32,35-53 drawn to a camera adapter.
Group II, claim(s) 33-34,54 drawn to an angiography filter assembly.

The inventions listed as Groups I and II do not relate to a single inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons: each of the inventions I, II is distinct from the other invention because of its mutual exclusive details. Each of these inventions recited limitations not recited in the other invention. The different limitations would make the inventions patentably distinct from one another, i.e. a reference that anticipated or makes obvious one of the inventions I,II would not, by itself, anticipated or makes obvious the remaining invention.